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The Effect of Cardiac Rehabilitation on Blood Lipids

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THE EFFECT OF CARDIAC REHABILITATION ON BLOOD LIPIDS

by

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CAROL LYNN BARTHOLOMEW. The Effect of Cardiac Rehabilitation on Blood Lipids. (Under the direction of Doris Nichols.)

The effect of cardiac rehabilitation on blood lipids was studied in a sample of seventeen male participants of the Greenville Hospital Center cardiac rehabilitation program. These subjects all suffered myocardial infarctions, but none had surgery to by-pass the obstructed coronary circulation. Paired values were obtained for triglyceride, serum cholesterol and HDL cholesterol before and after the exercise program. The time span between the before-exercise and after-exercise values ranged from five to thirty-one weeks. The differences in the paired values were analyzed by the t-test. No significant decrease occurred in triglyceride or serum cholesterol. A significant increase occurred in HDL cholesterol.

TABLE OF CONTENTS

CHAPTER I

INTRODUCTION

Statement of the Problem

Cardiovascular disease is the leading cause of death in the U. S. and many other industrialized countries. Coronary heart disease is the most common cardiovascular disease. The etiology of coronary heart disease is not known, but statistical association has been shown between certain risk factors and the increased incidence of coronary heart disease. Prospective epidemiological studies have resulted in the identification of these risk factors. Age, sex, family history, cigarette smoking, hypertension, hyperlipidemia, obesity, diabetes, physical inactivity and psychological stress are some of the factors consistently identified in studies.[1-6]

Studies such as the Framington Heart Study[1] have shown that the risk of coronary heart disease increases exponentially with each added risk factor. An assumption commonly made is that the risk of coronary heart disease can be reduced if the risk factors are reduced. A large number of risk factor modification studies substantiate the value of cardiac rehabilitation programs in prevention or reduction of coronary heart disease.[7-10]

The concept of cardiac rehabilitation is new. In the past, it was thought by most physicians that once a myocardial infarction had occurred, the patient should limit his activities and be content with a severely restricted lifestyle in order to prolong his life as long as possible. New advances in medicine have resulted in technology that enables the physician to better evaluate the patient and select reasonable functional goals for a cardiac rehabilitation program.

Lipids are organic substances which are insoluble in alcohol, ether, chloroform and other fat solvents. Hyperlipidemia is the elevation of lipid content in the blood. Three blood lipids are routinely included in the labwork analysis of patients who have had myocardial infarctions: serum cholesterol, HDL cholesterol and triglyceride. These were studied in post myocardial infarction patients participating in the cardiac rehabilitation program at Greenville Hospital Center.

Significance of the Problem

Since the statistical association has been established between coronary heart disease and the risk factors and since hyperlipidemia is one of the major risk factors, it should be beneficial to study the effect of a cardiac rehabilitation program on the blood lipids.

An assessment of any change that occurred might be helpful in modifying the design of the program.

Literature Review

The classic epidemiological studies on coronary heart disease were done in London, England by J. N. Morris[2]. He found a statistical association between sedentary jobs and increased heart disease in the London transit workers and later in the postal workers as well. The bus drivers and postal clerks had more coronary heart disease than the bus conductors and the active postmen. The early studies ignored the level of physical activity off the job. A study done in Los Angeles of civil service workers took this into consideration.[3] Gradually, research discovered a list of risk factors besides sedentary occupation. Age, sex, family history, hyperlipidemia, cigarette smoking, hypertension, obesity and stress were all identified as risk factors in studies.[4-6]

After many studies had substantiated the statistical association between the risk factors and coronary heart disease, research began in ways to modify the risk factors.

The emphasis was on physical exercise initially with studies such as the one by Mann.[7] After there was a general consensus on the benefit of exercise, studies were done on patients who had suffered myocardial infarctions. Rechnitzer[8] did a comparison on the effects of a twenty-four week exercise program on normals versus post myocardial infarction patients. He found that

exercise did indeed benefit both groups. The myocardial infarction group did show improvement in myocardial function.

Studies such as these laid the groundwork for cardiac rehabilitation programs. The traditional beliefs concerning treatment after myocardial infarction gradually changed and the myocardial infarction patient was placed on progressive activity programs rather than prolonged bedrest.[9, 10]

The blood lipids, in part, consist of cholesterol, triglycerides and phospholipids. All of the early studies were designed based on the assumption that lipids traveled in a free state in the blood. An important study by Frommeyer[11] revealed that these lipids join with proteins to form complexes called lipoproteins. The lipoproteins have a density less than 1.21 grams per milliliter and are divided into very low density lipoproteins (VLDL), low density lipoproteins (LDL) and high density lipoproteins (HDH).[11] The ratio of the lipid to protein determines the designation of high or low density lipoprotein.[11] For example, the LDL have a high ratio of lipid to protein. HDL have more protein, thus a lower ratio of lipid to protein.

It has been found that VLDL carry the endogenous triglyceride and some cholesterol.[11] The LDL carry more than one-half of the plasma cholesterol.[11] HDL carry phospholipids and

cholesterol.[11]

The cholesterol found in LDL is carried into the blood vessels and other tissues and thus might facilitate atherosclerosis.[12] In order for cholesterol to be removed from the cells, it must be esterified. HDL works with lecithin cholesterol acyl transferase, an enzyme, to esterify the cholesterol. Then, it is removed from the body by the liver.[13]

The classic studies on the hyperlipoproteinemias by Fredrickson, Levy and Lees[14] resulted in the classification of these disorders which is now widely accepted and used. Of the six types, (I, IIa, IIb, III, IV, and V), statistical association has been shown between atherosclerosis and types IIa, IIb, and III.[14] These three present with an elevation of cholesterol, as in IIa, or with elevations of both cholesterol and triglyceride, as in IIb and III.

An early study in 1951 by Barr et al[15] showed that healthy men had increased levels of HDL when compared to men with coronary heart disease. This was confirmed later by Brunner and Lobl.[16] Also, the Cooperative Lipoprotein Phenotyping Study by Castelli et al.[17] showed increased HDL in women. Statistics show that women have less coronary heart disease than men.

A recent study by Allison[18] reported significantly decreased HDL in college students who participated in an eight week exercise program. Further analysis

of subgroups showed increased HDL in students who had concomitant decreased triglyceride.

Studies by Erkelens[19] and Streja[20] reported increased HDL after programs of moderate exercise in patients who had had myocardial infarctions.

There is controversy in the literature about the effect of exercise on serum cholesterol. A study with rabbits by Myasnikov[21] is cited frequently in the literature. Reduced serum cholesterol levels were reported after exercise and the sedentary group of rabbits had higher levels of atherosclerosis.

This study was done at the Institute of Therapy of the Academy of Medical Sciences in Moscow, U.S.S.R. The report of the study contains only a superficial description of the research design and methods used. No actual blood cholesterol values were reported, and, in fact, it is not clear whether total serum cholesterol was measured or whether there was an attempt to measure lipoproteins.

Serum cholesterol levels in humans vary greatly worldwide. Gsell and Mayer[22] compared serum cholesterol in populations with similar diet and ethnic origin, but with differences in levels of physical activity. The data reveal lower serum cholesterol in the population with higher physical activity.

Mann, et. al.,[23] reported serum cholesterol levels decreased by 2.6 percent at the end of six months

of training. The participants were urban and professional men. This program began in the fall of 1967 with five exercise groups beginning the program at two week intervals. The twenty-eight men in the control group did not exercise. The program was suspended for a two week break at Christmas. The serum cholesterol levels before the holidays decreased significantly in the men in the exercise groups.[23] There was also a decrease at the borderline level of significance ($t = 1.99, 0.05 < p < 0.10$ in the control group.)[23] It has been suggested that seasonal variations might exist, explaining the decreased serum cholesterol in both the control and exercise groups at this time in the six month program.[23]

In the Mann study, the diet was evaluated with questionnaires repeatedly, but there was no recommended diet for the participants to follow. The participants were not advised to alter their body weight in any way.[23]

A study by Montoye[24] of the effect of six months of exercise on sedentary middle-aged men showed no effect on serum cholesterol levels among the men whose initial serum levels were considered normal. Three of the men had abnormally high levels before the program began. All three of these men had decreased levels of serum cholesterol post exercise.

Further analysis of all the men in the study

showed that the men who had a change in cholesterol also had a change in body weight, whether they were in the exercise group or not. This suggests that the combined effect of exercise and weight reduction result in decreased serum cholesterol.[24]

Hellerstein[25] studied the effect of exercise on men who had had myocardial infarctions. Serum cholesterol was decreased from a mean of 263 mgm/dl to 242 mgm/dl, at a $p < .05$.[34] He reported that the reduction occurred only in the groups which reduced body weight, adhered to the exercise program and adhered to the recommended diets low in saturated fats.

Conflicting results were reported in a study by Rechnitzer.[8] There were two groups of cardiac patients and two groups of sedentary men without history of cardiac problems. One group of cardiac patients and one group of sedentary men participated in the exercise program. Serum cholesterol increased in all four groups.

Although the report stated that diet was not controlled, subcutaneous fat measurements were made and the fat thickness decreased in the exercising groups. Weight loss occurred in the exercising groups and slight weight gain in the sedentary groups.[8]

In summary, there is controversy in the literature about the effect of exercise on serum cholesterol. The variables of weight, body fat and diet were considered in some studies and not in others. It should be noted

that most of the earlier studies did not partition the cholesterol measurements to show the separate lipoproteins.

The studies of the effect of exercise on triglyceride show a decrease post exercise. A study by Holloszy, et. al.,[26] showed a significant decrease in serum triglycerides in normals following a six month physical training program. The levels rose again approximately two days after each exercise session. This study, and other similar studies, were the basis for recommendation in most exercise programs of frequencies at least three times a week.

Conceptual Framework

Some assumptions were made about the participants in the cardiac rehabilitation program at the Greenville Hospital Center. First, all patients received standard and similar medical treatment during their cardiac rehabilitation program. Secondly, the patients followed medical recommendations as to diet, rest, home activity and exercise. Thirdly, the patients were sincere and interested enough to cooperate and participate fully in the program.

Since the data were results of labwork analysis, it needs to be assumed that these results were accurate, valid and reliable.

One final assumption was that the program at

the Greenville Hospital Center was representative of other cardiac rehabilitation programs.

The following three research questions were asked:

1. What is the effect of the cardiac rehabilitation program on serum triglyceride. The null hypothesis tested was that the difference between serum triglyceride levels before and after cardiac rehabilitation was less than or equal to zero.
2. What is the effect of the cardiac rehabilitation program on total serum cholesterol? The null hypothesis was that the difference between serum cholesterol levels before and after a cardiac rehabilitation program was less than or equal to zero.
3. What is the effect of the cardiac rehabilitation program on HDL cholesterol? The null hypothesis tested was that the difference between HDL cholesterol levels before and after a cardiac rehabilitation program was greater than or equal to zero.

There were several limitations considered in this research design. First, one could not assume that any changes that did occur were solely the result of the exercise due to the many other factors involved.

Second, myocardial infarctions vary in

severity and in this study there were no attempts to correlate this with the results of the cardiac rehabilitation program.

Third, patients were not referred to the cardiac rehabilitation program at a certain time post myocardial infarction. Furthermore, patients were not progresssed from one phase to the next at set times, but rather based on the individual's status and response to the program. Therefore, the paired values in this study represent before and after values with varying amounts of time lapsed between the myocardial infarction and the entry into the program. There were also varying amounts of time between the two values because the blood lipid analyses were usually done when the patient progressed from one phase to another of the program.

A number of terms must be defined for this project. The following definitions are from the Dorland's Medical Dictionary, The 24th Edition, 1965.

Lipid- Any one of a group of organic substances which are insoluble in water, but soluble in alcohol, ether, chloroform and other fat solvents and which have a greasy feel.

Lipoprotein- A combination of a lipid and protein, possessing the general properties of proteins.

Cholesterol- A fatlike, pearly substance, a monatomical alcohol, $C_{27}H_{45}OH$, crystallizing in the form of acicular crystals, and found in all animal

fats and oils, in bile, blood, brain tissues, milk, eggyolk, the medullated sheaths of nerve fibers, the liver, kidneys and adrenal glands.

Phospholipid- A lipid containing phosphorus, which on hydrolysis yields fatty acids, glycerin, and a nitrogenous compound.

Atherosclerosis- A lesion of large and medium-sized arteries, with deposits in the intima of yellowish plaques containing cholesterol, lipid material, and lipophages.

Exogenous- Developed or originating outside the organism.

Endogenous- Developed or originating within the organism.

CHAPTER II

METHODS AND PROCEDURES

Data Sources

Data were collected from the medical records of seventeen male participants in the Greenville Hospital Center Cardiac Rehabilitation Program who had suffered myocardial infarctions. The values from the first blood lipid studies done on each patient were recorded as the first of the paired values.

The values from the studies done closest to three months after the first studies were collected for the second on the paired values.

Only patients known to have suffered myocardial infarctions were chosen. Patients who had had open heart surgery were excluded. Patients who for some reason dropped out of the program before three months were excluded.

Analytical Techniques

Each of the three null hypothesis were tested at the .05 significance level. The difference in the paired values for triglyceride, serum cholesterol and HDL cholesterol were analyzed to determine whether each

null hypothesis was possible and probable based on the sample values. The means and standard deviations were calculated. A t-test was done on the paired samples. The t values were computed and compared to the critical value of t(1.746).

CHAPTER III

RESULTS

Table 1 shows the paired values for triglyceride in the seventeen participants. The difference of each individual pair (D) is recorded. The average difference ($\bar{d}$) is +20.59 mg/dl. The standard deviation is 75.1. The computed t value is 1.130. Thus the first null hypothesis is accepted. Based on this sample, it is possible and probable that the difference in the paired triglyceride values is less than or equal to zero. The triglyceride was not reduced significantly post exercise.

Table 2 shows the paired values for serum cholesterol in the seventeen participants. The difference of each individual pair (D) is recorded. The average difference ($\bar{d}$) is +4.12mg/dl. The standard deviation is 31.4. The computed t value is 0.541. Thus the second null hypothesis is accepted. Based on this sample, it is both possible and probable that the difference in the paired cholesterol values is less than or equal to zero. The serum cholesterol is not significantly reduced post exercise.

Table 3 shows the paired values of HDL cholesterol in the seventeen participants. The difference of each individual pair (D) is recorded. The

average difference ($\bar{d}$) is -3.82. The standard deviation is 8.8. The computed t value is -1.784. Thus the third null hypothesis is rejected. Based on this sample, it is neither possible nor probable that the difference in HDL levels before and after exercise is more than or equal to zero. The HDL levels were significantly increased post exercise.

TABLE 1

TRIGLYCERIDE

SAMPLE	TIME SPAN (WEEKS)	BEFORE C.R. (mg/dl)	AFTER C.R. (mg/dl)	DIFFERENCE
1	8	350	165	185
2	16	388	388	0
3	13	85	69	16
4	12	81	102	-21
5	11	277	142	135
6	25	191	186	5
7	12	111	129	-18
8	20	111	83	28
9	17	159	262	-103
10	11	204	190	14
11	31	219	213	6
12	9	389	253	136
13	11	127	188	-61
14	26	273	222	51
15	10	369	417	-48
16	11	266	204	62
17	5	176	213	-37
MEAN		$\bar{X} = 222.1$	$\bar{X} = 201.5$	$\bar{X} = 20.59$

t value 1.130 $t_{.05}$ 1.746

TABLE 2

SERUM CHOLESTEROL

SAMPLE	TIME SPAN (WEEKS)	BEFORE C.R. (mg/dl)	AFTER C.R. (mg/dl)	DIFFERENCE
1	8	291	247	44
2	16	184	197	-13
3	13	197	183	14
4	12	107	123	-16
5	11	188	201	-13
6	25	183	217	-34
7	12	270	284	-14
8	20	172	124	48
9	17	230	244	-14
10	11	152	165	-13
11	31	259	241	18
12	9	255	178	77
13	11	173	182	-9
14	26	235	217	18
15	10	145	192	-47
16	11	194	191	3
17	5	252	231	21

TABLE 3

HDL CHOLESTEROL

SAMPLE	TIME SPAN (WEEKS)	BEFORE C.R. (mg/dl)	AFTER C.R. (mg/dl)	DIFFERENCE
1	8	52	53	-1
2	16	17	26	-9
3	13	34	37	-3
4	12	39	38	1
5	11	24	33	9
6	25	33	37	-4
7	12	44	44	0
8	20	27	31	-4
9	17	38	70	-32
10	11	32	29	3
11	31	32	34	-2
12	9	36	41	-5
13	11	28	41	-13
14	26	29	30	-1
15	10	30	26	4
16	11	31	37	-6
17	5	41	43	-2
MEAN		$\bar{X} = 33.5$	$\bar{X} = 38.2$	$\bar{X} = -3.82$

t value $\underline{-1.784}$ $t_{.05}$ $\underline{-1.746}$

CHAPTER IV

SUMMARY AND CONCLUSIONS

No significant decrease was found in triglyceride levels in this sample of the participants of the Greenville Hospital Center cardiac rehabilitation program. Since previous studies in the literature report a decrease in triglyceride after exercise which lasts up to forty-eight hours, several factors must be considered to explain the results of this study.

First, although the exercise sessions were scheduled three times a week, there was no attempt in this study to determine whether the subjects did, in fact, attend all of the sessions. If subjects attended less than three times per week, this might not have been an effective frequency.

Second, the exact time of blood collection should have been recorded. For example, if the blood had been drawn on Monday morning before exercise, it might have been seventy-two hours or more since the last exercise session.

Third, the intensity of the exercise was not assessed. The study by Holloszy[26] was done on middle-aged men. Since the subjects in the present study had had myocardial infarctions, they may not have been able

to exercise at an intensity great enough to decrease triglyceride.

Finally, the length of time between the before and after paired values ranged from five to thirty-one weeks with each subject. The shorter periods of time may not have allowed sufficient time in the exercise program for a reduction of triglyceride to occur. Further analysis might be indicated to correlate the time of exercise to changes in triglyceride.

Conflicting results are reported in the literature on the effect of exercise on serum cholesterol. No significant decrease in serum cholesterol occurred in this sample of the participants of the Greenville Hospital Center cardiac rehabilitation program.

In some of the literature reporting decreased serum cholesterol post exercise, there was little or no information on diet and weight changes. In the study by Mann[23] where a decrease did occur after six months of training, no nutritional counseling was done and there was no report of diet or weight changes that occurred along with the decreased cholesterol.

The study by Montoye[24] on middle-aged men showed decreased cholesterol only in the three men who had abnormally high levels of cholesterol to begin with. This suggests the need for further studies on the effect of exercise on cholesterol in men divided into groups according to initial serum cholesterol levels and

possibly groups of men of different ages as well.

The study by Montoye also showed that men who had a change in cholesterol also had a change in body weight.[24] Hellerstein reported that the reduction in cholesterol occurred only in the groups which reduced body weight, adhered to the exercise program and diets.[25]

The Greenville Hospital Center cardiac rehabilitation program did include diet questionnaires. Nutritional counseling was offered on low saturated fat diets. Weight reduction diets were recommended when indicated. The participants were weighed weekly and posters in the exercise room charted their progress for all to see. It would seem that all of this would help provide motivation for the participants to modify diet, lose weight and adhere to the exercise program. Since all of these data could be retrieved easily from the medical records, further studies are indicated to collect and analyze these data.

A significant increase in HDL cholesterol occurred in the seventeen subjects of this study after exercise. Analysis of the subgroups in Allison's study[18] showed a negative association between HDL and triglyceride levels. Although HDL increased in the present study, the concomitant decrease in triglyceride was not observed. When comparing results of these studies, one must remember that the population in

Allison's study consisted of healthy young college students, both male and female, while the subjects of the present study were all men who had suffered myocardial infarction.

The results of the present study are similar to those of both the Erkelens and Streja studies.[19,20] The populations were similar in that all three groups had had myocardial infarctions and subsequently participated in cardiac rehabilitation programs. Significant increases in HDL cholesterol were reported in each of these studies.

None of the subjects had had surgery to by-pass obstructed coronary circulation. Many other participants in the cardiac rehabilitation program had had coronary artery by-pass grafts to relieve the obstruction in the vessels. Further studies are indicated in this program to compare the effects of exercise on blood lipids in the surgery versus non-surgery groups.

Of the studies previously cited in the literature review where subjects were labeled as cardiac patients or post myocardial infarction patients, it is not clear whether surgery patients were excluded from the studies as they were in this study.

The results of the present study suggest that in male patients who have had myocardial infarctions, an increase in HDL cholesterol can be expected as a result of the participation in the cardiac rehabilitation

program. A corresponding decrease in triglyceride and serum cholesterol cannot be expected based on the results of this study.

Further studies are indicated to study the variables such as age, frequency of exercise, intensity of exercise, duration of exercise, time of blood collection, changes in diet, body weight and body fat.

No attempt was made to categorize any of the initial blood lipid values as normal or abnormal. Further studies designed to look at these categories individually might be helpful.

In summary, paired blood lipid values for triglyceride, serum cholesterol and HDL cholesterol were collected from a sample of seventeen male post-myocardial infarctions participants of the Greenville Hospital Center cardiac rehabilitation program. The first value of each pair represents the first set of lipid analyses done upon entry into the program. The second value of each pair represents the after-exercise value and ranges from five to thirty-one weeks after the first value.

No significant decrease was found in either triglyceride or serum cholesterol after exercise. A significant increase in HDL cholesterol was found after exercise.

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